

(PCT Article 36 and Rule 70)

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/DE2004/002507

Box No. I

Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language _____, which is the language of a translation furnished for the purposes of:
- ☐ international search (Rule 12.3 and 23.1(b))
- ☐ publication of the international application (Rule 12.4)
- ☐ international preliminary examination (Rule 55.2 and/or 55.3)
2. With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:
- ☐ the international application as originally filed/furnished
- ☒ the description:
- pages 1, 2 _____ as originally filed/furnished
- pages* _____ received by this Authority on _____
- pages* _____ received by this Authority on _____
- ☒ the claims:
- nos. _____ as originally filed/furnished
- nos.* _____ as amended (together with any statement) under Article 19
- nos.* 1, 2 _____ received by this Authority on 10.10.2005 with letter of 10.10.2005
- nos.* _____ received by this Authority on _____
- ☐ the drawings:
- sheets _____ as originally filed/furnished
- sheets* _____ received by this Authority on _____
- sheets* _____ received by this Authority on _____
- ☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.
3. ☒ The amendments have resulted in the cancellation of:
- ☐ the description, pages _____
- ☒ the claims, nos. 3, 4 _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to sequence listing (*specify*): _____
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages _____
- ☐ the claims, nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to sequence listing (*specify*): _____

* If item 4 applies, some or all of those sheets may be marked "superseded."

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Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement		
1.	Statement		
	Novelty (N)	Claims <u>1, 2</u>	YES
		Claims _____	NO
	Inventive step (IS)	Claims <u>1, 2</u>	YES
		Claims _____	NO
	Industrial applicability (IA)	Claims <u>1, 2</u>	YES
		Claims _____	NO
2.	Citations and explanations (Rule 70.7)		
	Reference is made to the following document:		
	D1: EP-A-1 314 507		
	<u>Novelty</u>		
	<p>The amended claim 1 is novel. The cited prior art discloses a process for producing a turbine wheel using "blisk" technology, whereby the blades are electrochemically machined with cathode tools (see in particular document D3 (EP-A-1 314 507, but also EP 0 327 657 A1 and EP 0 292 213 A1)), and also surface structuring using electrochemical machining methods (see in particular D1 and D2). However, none of the cited documents disclose a single combined production step for simultaneously producing turbine blades and machining the blade surfaces using a boundary-layer-minimising structure that is a reverse image of the cathode tool surface.</p> <p>Thus none of the processes disclosed in the cited prior art have all the features specified in the amended claim 1. The amended claim 1 is therefore novel (PCT Article 33(2)).</p>		

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Inventive step

Document D3 discloses a process for producing blades on the outer circumference of a turbine wheel using "blisk" technology, the contouring being achieved by electrochemical machining with cathode tools. In view of the modified focus of the claims, document D3 can be regarded as the closest prior art.

The process according to the amended claim 1 differs from what is known from D3 in that at the contouring stage, in a single production step, the surfaces of the blades are provided with a boundary-layer-minimising structure that is a reverse image of the cathode tool surface. The technical effect is the fact that the blades can be made in a single production step, and that with the structure-modified cathode tools it is possible to contour the blades and at the same time apply a boundary-layer-minimising structure.

Thus the objective problem addressed by the invention is that of how to modify the process of D3 in such a way as to speed up blade production.

The problem is solved by the process defined in the amended claim 1, according to which at the contouring stage, in a single production step, the surfaces of the blades are provided with a boundary-layer-minimising structure that is a reverse image of the cathode tool surface.

This solution is not obvious for the following reasons:

Document D3 (and also in EP 0 327 657 A1 and EP 0 292 213 A1)

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	<p>shows only how the blade blanks have to be moved relative to the cathodes during the electrochemical machining process in order to achieve their aerodynamic contouring. Because of the special blade geometry, the cathodes are moved both towards each other and relative to the blade blanks. The cathodes are also turned relative to the blade blanks. However, there is no mention in any of these documents of machining the blade surfaces with a boundary-layer-minimising structure that is a reverse image of the cathode tool surface.</p> <p>Documents D1 and D2 disclose processes for rejuvenating cooling passages by electrochemical machining. Structures are introduced into the passages to create turbulence in the cooling air that flows through the them. The turbulence is intended to increase the efficiency of the energy/heat transfer from the cooling passage surfaces to the cooling air so as to improve the cooling effect.</p> <p>Thus the structures disclosed in D1 and D2 are not boundary-layer-minimising structures. In contrast to the structures of D1 and D2, the boundary-layer-minimising structures are designed to eliminate turbulence so as to increase the efficiency of the blades by ensuring a laminar, turbulence-free flow. For this reason, boundary-layer-minimising surface structures differ entirely in their complexity from the turbulence-creating structures of D1 and D2.</p> <p>Moreover, the cooling passage surfaces in D1 and D2 are structured by introducing the cathodes into the passages, but they are not moved during the electrochemical machining process. In particular, there would be no other way to</p>

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create the circular or linearly interrupted turbulator structures.

This is why there are adjacent conductive and insulating regions on the surface of the cathode.

Moving the cathodes in D1 and D2 would result in surface structures that were completely different from what was required, and therefore they are not moved.

At most, the teachings of D1 and D2 might indicate to a person skilled in the art that in order to apply boundary-layer-minimising structures to the surfaces, the cathodes should not be moved relative to the blades. As a result, the skilled person would not combine the techniques disclosed in D3 and D1/D2 in a single step for the electrochemical machining of blade blanks, because in one instance relative movement is necessary but in the other instance it would cause damage.

Taking D3 as the closest prior art, the skilled person would therefore not be able to arrive at the full combination of features in the amended claim 1. The rotor blade claimed in the amended claim 1 therefore involves an inventive step (PCT Article 33(3)).

The remaining claim (claim 2) relates to a special embodiment of the process according to the amended claim 1, and is therefore also novel and inventive.